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DEVICE AND METHOD FOR MANUFACTURING ORGANIC EL ELEMENT

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Translation Attached

ABSTRACT

PROBLEM TO BE SOLVED: To provide a device and a method for manufacturing an organic EL element, corresponding to a base board having the relative large area, having a little fluctuation of the distribution of a film thickness, and capable of efficiently mass-producing organic EL elements.

SOLUTION: In a manufacturing device for an organic EL element, a base plate 2 on which an organic EL element is to be formed and an evaporation source 4 are provided, an (n) value as a value approximated by m/m .varies. $O(LO/L)^{sup 2} \cdot \cos(n)^{sup 2} \cdot \theta$. which is the ratio of the vapor density (m) in the optional position separated from an opening part at the distance L at the radiation angle θ . from the central line of the opening part to the vapor density m_0 in the central part on the opening part of the evaporation source 4 at the distance LO from the opening part is in the range of 3 to 6, the evaporation source 4 in relation to the base plate 2 is arranged in the position of 1.0 to 1.4 times of the distance from the center C/L of the base plate 2 to the end of the base plate 2, and the vertical distance from the opening part of the evaporation source 4 to the base plate 2 is 1.5 to 3.5 times of the distance from the center of the base plate 2 to the end. A film is formed by using this device.

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DEVICE AND METHOD FOR MANUFACTURING ORGANIC EL ELEMENT (English)

Patent Assignee: TDK CORP

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Organic EL element manufacturing apparatus - establishes
predetermined distance between centre of substrate and evaporation
source, and edge of substrate and centre of opening in evaporation source

Patent Assignee: TDK CORP (DENK)

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Abstract (Basic): JP 10335062 A

NOVELTY - The vertical distance between centre (C/L) of substrate (2) and evaporation source (4) is set in the range of 1.0-1.4. The distance between centre of opening of evaporation source and edge of substrate is set in the range of 1.5-3.5.

USE - None given.

ADVANTAGE - Reduces variation in film thickness. Ensures mass production. DESCRIPTION OF DRAWING(S) - The selected figure is a chart showing the manufacturing apparatus. (2) Substrate; (4) Evaporation source.

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Derwent Class: L03; M13; U14; X26

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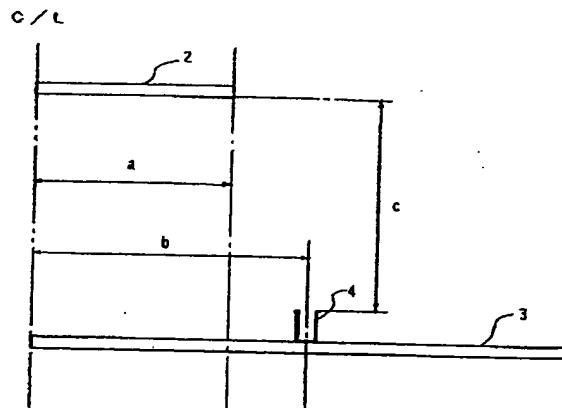
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(54)【発明の名称】 有機EL素子の製造装置および製造方法

(57)【要約】

【課題】 比較的大きな面積の基板に対応し、膜厚分布の変動が少なく、有機EL素子を効率よく量産することができる有機EL素子の製造装置および製造方法を実現する。

【解決手段】 有機EL素子が形成される基板2と、蒸発源4とを有し、前記蒸発源4の開口部上の中心で開口部よりL0の距離における蒸気密度m0に対する開口部の中心線からの放射角θで開口部より距離し離れた任意の位置での蒸気密度mの比 $m/m_0 \propto (L_0/L)^2 \cdot \cos^2 \theta$ で近似したときの値であるn値が、3~6であって、前記基板2に対する蒸発源4の位置を、基板2の中央C/しに対して、基板2の中央C/しから基板2の端部までの距離の1.0~1.4倍の位置に配置し、前記蒸発源4の開口部から基板2までの垂直距離が、基板2の中央から端部までの距離の1.5~3.5倍である有機EL素子の製造装置とし、この装置を用いて成膜することとした。



【特許請求の範囲】

【請求項1】 有機EL素子が形成される基板と、蒸発源とを有し、前記蒸発源の開口部上の中心で開口部より L_0 の距離における蒸気密度 m_0 に対する開口部の中心線からの放射角 θ で開口部より距離 L 離れた任意の位置での蒸気密度 m の比 $m/m_0 \propto (L_0/L)^2 \cdot \cos^2 \theta$ で近似したときの値である n 値が、3~6 であって、前記基板に対する蒸発源の位置を、基板の中央に対して、基板の中央から基板の端部までの距離の 1.0~1.4 倍の位置に配置し、前記蒸発源の開口部から基板までの垂直距離が、基板の中央から端部までの距離の 1.5~3.5 倍である有機EL素子の製造装置。

【請求項2】 前記基板は最大長が 200~600 μm である請求項1の有機EL素子の製造装置。

【請求項3】 形成される有機層の膜厚の膜厚分布が ±10% 以内である請求項1または2の有機EL素子の製造装置。

【請求項4】 有機EL素子が形成される基板を真空槽内に配置し、蒸発源を、前記基板の中央に対して、基板の中央から基板の端部までの距離の 1.0~1.4 倍の位置であって、前記蒸発源の開口部から基板までの垂直距離が、基板の中央から端部までの距離の 1.5~3.5 倍である位置に配置し、

前記蒸発源の n 値を 3~6 として蒸着を行う有機EL素子の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は有機EL素子の製造装置に関し、詳しくは、加熱により有機EL素子用の有機原料物質を蒸発させ、これを基板上の成膜領域に堆積させることで薄膜を形成する蒸着法を用いた有機EL素子の製造装置に関する。

【0002】

【従来の技術】 薄膜形成を行う基本技術の1つとして、真空蒸着法が知られている。この真空蒸着法は、真空槽内で蒸発源と成膜用基板を適当に組み合わせて、薄膜を形成するものである。蒸発源を作る手段も様々考えられており、例えば、Appl. Phys. Lett. 68(16), 15 April 1996 に記載されているような、比較的電気抵抗の高い金属容器（金属ボード）に電流を流し、その発熱により原料を蒸発させるいわゆる抵抗加熱蒸着法が知られている。また、原料に直接電子ビームやレーザービームを照射し、そのエネルギーで原料を蒸発させるいわゆる電子ビーム・レーザービーム蒸着法等も知られている。中でも抵抗加熱を用いた成膜方法（抵抗加熱蒸着法）は、成

膜装置の構成が簡便であり、低価格で良質の薄膜形成を実現できることから広く普及している。

【0003】 抵抗加熱蒸着法は、融点の高いタンゲステン、タンタル、モリブデン等の金属材料を薄板状に加工して、電気抵抗を高くした金属板から原料容器（金属ボード）を作製し、その両端から直流電流を流し、その発熱を用いて原料を蒸発させ、蒸発ガスを供給している。図3はこのような抵抗加熱蒸着装置の構成を示した概略構成図で、真空槽内 1 に基板 S と、この基板 S と対抗して金属ボード 4b を配置し、この金属ボード 4b により形成された原料容器 4a の上部には小さな穴が設けられていて、この穴から加熱により原料ガス V が発散する。発散したガスの一部が基板 S 上に堆積し、薄膜が形成される。蒸発原料として使用できるものは、蒸気圧の比較的高いものであれば何でも良いが、原料容器と容易に化学反応するものは避ける必要がある。

【0004】 このような抵抗加熱装置の場合、有機層へのダメージも少なく、陰電極等の有機EL素子の構成薄膜を蒸着する装置として優れた面を有している。しかし、このような真空蒸着装置で成膜できる基板の大きさは、均一な膜厚を得ようとすると、100×100 μm と比較的小型のものに限られていた。このため、有機EL素子を応用したディスプレイ等を量産しようとした場合、一度に製造できるディスプレイの数が少なく、生産効率が低い。また、製造可能な画面の大きさも限られてしまい、ディスプレイの大画面化への対応が困難であった。

【0005】 一方、膜厚の変動を無視して製膜した場合、ある程度の大きさの基板でも成膜可能であるが、特性が安定せず、不良品率が多くなったり、一つのディスプレイ内で輝度のバラツキや表示ムラが多くなったりして、実用に耐えうる品質のものを得ることが困難であった。

【0006】

【発明が解決しようとする課題】 この発明の目的は、比較的大きな面積の基板に対応し、膜厚分布の変動が少なく、有機EL素子を効率よく量産することのできる有機EL素子の製造装置および製造方法を実現することである。

【0007】

【課題を解決するための手段】 上記の目的は、以下の(1)~(4)の構成により実現される。

(1) 有機EL素子が形成される基板と、蒸発源とを有し、前記蒸発源の開口部上の中心で開口部より L_0 の距離における蒸気密度 m_0 に対する開口部の中心線からの放射角 θ で開口部より距離 L 離れた任意の位置での蒸気密度 m の比 $m/m_0 \propto (L_0/L)^2 \cdot \cos^2 \theta$ で近似したときの値である n 値が、3~6 であって、前記基板に対する蒸発源の位置を、基板の中央に対して、基板の中央から基板の端部までの距離の 1.0~1.4 倍

の位置に配置し、前記蒸発源の開口部から基板までの垂直距離が、基板の中央から端部までの距離の1.5~3.5倍である有機EL素子の製造装置。

(2) 前記基板は最大長が200~600mmである上記(1)の有機EL素子の製造装置。

(3) 形成される有機層の膜厚分布が±10%以内である上記(1)または(2)の有機EL素子の製造装置。

(4) 有機EL素子が形成される基板を真空槽内に配置し、蒸発源を、前記基板の中央に対して、基板の中央から基板の端部までの距離の1.0~1.4倍の位置であって、前記蒸発源の開口部から基板までの垂直距離が、基板の中央から端部までの距離の1.5~3.5倍である位置に配置し、前記蒸発源のn値を3~6として蒸着を行う有機EL素子の製造方法。

【0008】

【発明の実施の形態】本発明の有機EL素子の製造装置は、有機EL素子が形成される基板と、蒸発源とを有し、前記蒸発源の開口部上の中心で開口部よりL0の距離における蒸気密度m0に対する開口部の中心線からの放射角θで開口部より距離t離れた任意の位置での蒸気密度mの比m/m0 $\propto (L0/L)^2 \cdot \cos \theta$ で近似したときの値であるn値が、3~6であって、前記基板に対する蒸発源の位置を、基板の中央に対して、基板の中央から基板の端部までの距離の1.0~1.4倍の位置に配置し、前記蒸発源の開口部から基板までの垂直距離が、基板の中央から端部までの距離の1.5~3.5倍である位置に配置するものである。このように、一定範囲のn値に対して、蒸発源の位置を基板の中央から所定の位置に配置することにより、均一な膜厚分布が得られる。

【0009】基板としては特に限定されるものではなく、有機EL素子が積層可能なものであればよいが、発光した光を取り出す側の場合、ガラスや石英、樹脂等の透明ないし半透明材料を用いる。また、基板に色フィルター膜や蛍光性物質を含む色変換膜、あるいは誘電体反射膜を用いて発光色をコントロールしてもよい。また、発光した光を取り出す側ではない場合には、基板は透明でも不透明であってもよく、不透明である場合にはセラミックス等を使用してもよい。

【0010】基板の大きさも特に限定されるものではないが、好ましくは最大長、特に対角長が200~700mm、特に400~700mmの範囲が好ましい。最大長は200mm以下であっても問題ないが、特に200mm以上の基板で均一な膜厚分布を得ることができ好ましい。また、基板の大きさが700mmを超えると成膜装置が大型化し、成膜効率が低下し、膜厚制御が困難になってくる。

【0011】蒸発源は有機EL素子の各材料と容易に化学反応せず、これらを所定n値の蒸気に拡散しうるもの

であれば特に限定されるものではないが、好ましくはクヌードセンセル(Knudsen Cell: 以下Kセルと呼ぶ場合がある)が好ましい。クヌードセンセルは、蒸気噴出口に所定の開口部を有するセルである。開口部の開口径dと厚さtをパラメータとして、噴出口の上に立つ蒸気密度の分布は、ローソクの炎状をなしており、 $\cos \theta$ の形で近似される。ここで、n値とは中心の蒸気密度m0に対する任意の位置での蒸気密度mの比m0/m $\propto \cos \theta$ で近似したときの値である。d/tが小さくなるにつれてnの値は大きくなり、炎の形は鋭くなる。最極端のt=0の場合、n=1になり、開口部の上に立つ球状の分布になる。これは開放された液面からの蒸発に相当し、ラングミュア(Langmuir)蒸発と呼ばれる。

【0012】前記n値は、d/t等を制御して3~6に規制する。このようにn値に一定の範囲を与えたのは、蒸発源の開口部、つまりオリフィスから蒸発する蒸気は一定ではなく、n値も変動するため、この範囲のn値であれば問題なく動作する。n値が上記値より小さいと拡散方向が広がりすぎて成膜効率が低下する。n値が上記値より大きいと指向性が強くなり、大型の基板への対応が困難になる。

【0013】蒸発源の位置は、基板の中央に対して、基板の中央から基板の端部までの距離の1.0~1.4倍、好ましくは1.0~1.3倍、特に1.1~1.3倍の位置に、また、蒸発源開口部から基板までの垂直距離が、基板の中央から端部までの距離の1.5~3.5倍、好ましくは1.5~3.0、特に1.5~2.5倍の位置に配置する配置する。基板の中央から所定の距離だけ離れた位置に配置させることにより、膜厚分布を一定値以内とすることができる、特性の安定した有機EL素子を得ることができる。蒸発源は、上記範囲内であれば複数個を、基板中心に対して同心円上に配置してもよい。この場合には、共蒸着を行うことができる。

【0014】成膜された薄膜の膜厚分布は、好ましくは±10%以内、特に9%以内、さらには8%以内が好ましい。膜厚分布が±10%を超えると有機EL素子の特性が不安定となる。

【0015】本発明の装置により成膜される有機EL素子の薄膜としては、ホール注入・輸送層、発光および電子注入輸送層、電子注入電極、保護層等が挙げられ、これらと同一組成、あるいは蒸着により同一組成となる金属材料、合金、有機材料等が挙げられる。

【0016】電子注入電極としては、低仕事関数の物質が好ましく、例えば、K、Li、Na、Mg、La、Ce、Ca、Sr、Ba、Al、Ag、In、Sn、Zn、Zr等の金属元素単体、または安定性を向上させるためにそれらを含む2成分、3成分の合金系を用いることが好ましい。合金系としては、例えばAg-Mg(Ag:1~20at%)、Al-Li(Li:0.5~10at%)、In-Mg(Mg:50~80at%)、Al-

Ca (Ca: 5~20at%) 等が好ましい。

【0017】保護層としては、金属材料、SiO_x 等の無機材料、テフロン等の有機材料等が挙げられる。

【0018】発光層には発光機能を有する化合物である蛍光性物質が用いられる。このような蛍光性物質としては、例えば、特開昭63-264692号公報に開示されているような化合物、例えばキナクリドン、ルブレン、スチリル系色素等の化合物から選択される少なくとも1種が挙げられる。また、トリス(8-キノリノラト)アルミニウム等の8-キノリノールないしその誘導体を配位子とする金属錯体色素などのキノリン誘導体、テトラフェニルブタジエン、アントラセン、ペリレン、コロネン、1,2-フタロペリノン誘導体等が挙げられる。さらには、特願平6-110569号のフェニルアントラセン誘導体、特願平6-114456号のテトラアリールエテン誘導体等を用いることができる。

【0019】また、それ自体で発光が可能なホスト物質と組み合わせて使用することが好ましく、ドーバントとしての使用が好ましい。このような場合の発光層における化合物の含有量は0.01~1.0wt%、さらには0.1~5wt%であることが好ましい。ホスト物質と組み合わせて使用することによって、ホスト物質の発光波長特性を変化させることができ、長波長に移行した発光が可能になるとともに、素子の発光効率や安定性が向上する。

【0020】ホスト物質としては、キノリノラト錯体が好ましく、さらには8-キノリノールないしその誘導体を配位子とするアルミニウム錯体が好ましい。このようなアルミニウム錯体としては、特開昭63-264692号、特開平3-255190号、特開平5-70733号、特開平5-258859号、特開平6-215874号等に開示されているものを挙げることができる。

【0021】具体的には、まず、トリス(8-キノリノラト)アルミニウム、ビス(8-キノリノラト)マグネシウム、ビス(ベンゾ{f}-8-キノリノラト)亜鉛、ビス(2-メチル-8-キノリノラト)アルミニウムオキシド、トリス(8-キノリノラト)インジウム、トリス(5-メチル-8-キノリノラト)アルミニウム、8-キノリノラトリチウム、トリス(5-クロロ-8-キノリノラト)ガリウム、ビス(5-クロロ-8-キノリノラト)カルシウム、5,7-ジクロロ-8-キノリノラタルミニウム、トリス(5,7-ジプロモ-8-ヒドロキシキノリノラト)アルミニウム、ポリ[亜鉛(II)-ビス(8-ヒドロキシ-5-キノリニル)メタン]、等がある。

【0022】また、8-キノリノールないしその誘導体のほかに他の配位子を有するアルミニウム錯体であってもよく、このようなものとしては、ビス(2-メチル-8-キノリノラト)(フェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(オルト-

クレゾラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(メタ-クレゾラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(パラ-クレゾラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(オルト-フェニルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(メタ-フェニルフェノラト)アルミニウム(II)、ビス(2-メチル-8-キノリノラト)(パラ-フェニルフェノラト)アルミニウム(II)、ビス(2-メチル-8-キノリノラト)(2,3-ジメチルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(2,6-ジメチルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(3,4-ジメチルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(3,5-ジメチルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(3,5-ジ-tert-ブチルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(2,6-ジフェニルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(2,4,6-トリフェニルフェノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(2,3,6-トリメチルフェノラト)アルミニウム(I)、ビス(2-メチル-8-キノリノラト)(2,3,5,6-テトラメチルフェノラト)アルミニウム(I)、ビス(2-メチル-8-キノリノラト)(1-ナフトラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)(2-ナフトラト)アルミニウム(II)、ビス(2,4-ジメチル-8-キノリノラト)

30 (オルト-フェニルフェノラト)アルミニウム(III)、ビス(2,4-ジメチル-8-キノリノラト)(パラ-フェニルフェノラト)アルミニウム(III)、ビス(2,4-ジメチル-8-キノリノラト)(メタ-フェニルフェノラト)アルミニウム(III)、ビス(2,4-ジメチル-8-キノリノラト)(3,5-ジメチルフェノラト)アルミニウム(III)、ビス(2,4-ジメチル-8-キノリノラト)(3,5-ジ-tert-ブチルフェノラト)アルミニウム(III)、ビス(2-メチル-4-エチル-8-キノリノラト)(パラ-クレゾラト)アルミニウム(III)、ビス(2-メチル-4-メトキシ-8-キノリノラト)(パラ-フェニルフェノラト)アルミニウム(III)、ビス(2-メチル-5-シアノ-8-キノリノラト)(オルト-クレゾラト)アルミニウム(III)、ビス(2-メチル-6-トリフルオロメチル-8-キノリノラト)(2-ナフトラト)アルミニウム(III)等がある。

【0023】このほか、ビス(2-メチル-8-キノリノラト)アルミニウム(III)-ヌ-オキソ-ビス(2-メチル-8-キノリノラト)アルミニウム(III)、ビス(2-メチル-8-キノリノラト)アルミニウム(III)

50 (2,4-ジメチル-8-キノリノラト)アルミニウム

(III) - μ -オキソービス(2,4-ジメチル-8-キノリノラト)アルミニウム(III)、ビス(4-エチル-2-メチル-8-キノリノラト)アルミニウム(III) - μ -オキソービス(4-エチル-2-メチル-8-キノリノラト)アルミニウム(III)、ビス(2-メチル-4-メトキシキノリノラト)アルミニウム(III) - μ -オキソービス(2-メチル-4-メトキシキノリノラト)アルミニウム(III)、ビス(5-シアノ-2-メチル-8-キノリノラト)アルミニウム(III) - μ -オキソービス(5-シアノ-2-メチル-8-キノリノラト)アルミニウム(III)、ビス(2-メチル-5-トリフルオロメチル-8-キノリノラト)アルミニウム(III) - μ -オキソービス(2-メチル-5-トリフルオロメチル-8-キノリノラト)アルミニウム(III) 等であってよい。

【0024】このほかのホスト物質としては、特願平6-110569号に記載のフェニルアントラセン誘導体や特願平6-114456号に記載のテトラアリールエテン誘導体なども好ましい。

【0025】発光層は電子注入輸送層を兼ねたものであってもよく、このような場合はトリス(8-キノリノラト)アルミニウム等を使用することが好ましい。これらの蛍光性物質を蒸着すればよい。

【0026】電子注入輸送性の化合物としては、キノリン誘導体、さらには8-キノリノールないしその誘導体を配位子とする金属錯体、特にトリス(8-キノリノラト)アルミニウム(A1q3)を用いることが好ましい。また、上記のフェニルアントラセン誘導体、テトラアリールエテン誘導体を用いるのも好ましい。

【0027】ホール注入輸送層用の化合物としては、強い蛍光を持ったアミン誘導体、例えば上記のホール輸送材料であるトリフェニルジアミン誘導体、さらにはスチリルアミン誘導体、芳香族縮合環を持つアミン誘導体を用いるのが好ましい。

【0028】蒸着時の圧力は好ましくは $1 \times 10^{-8} \sim 1 \times 10^{-5}$ Torrで、蒸発源の加熱温度は、金属材料であれば100~1400°C、有機材料であれば100~500°C程度が好ましい。

【0029】次に、本発明の製造装置のより具体的な構成について、図を参照しつつ説明する。

【0030】図1は本発明装置の基本構成を示す半裁断面図である。図において、本発明の有機EL素子の製造装置は、基板2と、蒸発源載置台3と、蒸発源4とを有する。図は基板2の中央C/しから右半分を示している。従って、蒸発源4は、基板中央から端部までの距離aと、その1.4倍の距離bとの間であって、蒸発源4の開口部24から基板2までの垂直距離cが、基板2の中央C/しから端部までの距離の1.5~3.5倍である位置に配置されることになる。なお、蒸発源4の位置は、蒸発源4の中心の位置とする。

【0031】図2は、本発明に好ましく使用される蒸発源4のより具体的な構成を示した要部断面図である。図において、蒸発源4は、外部ケース21と、断熱材22と、るっぽ23と、開口部24と、材料25と、加熱手段26と、温度検出手段27とを有する。

【0032】るっぽ23は蒸着される材料25と容易に化学反応せず、所定の温度に耐えうるもののが好ましく、例えばバイオライティックポロンナイトライド(PBN)、アルミナ等のセラミックス、石英等が挙げられ、10特にPBN等が好ましい。外部ケース21は、所定の強度と耐腐食性等を備えたものであれば特に限定されるものではなく、下記断熱材22と同様のものの中から選択すればよく、あるいはこれと兼用してもよく、例えばモリブデン等を好ましく用いることができる。断熱材22は、熱反射性、耐熱性、耐腐食性等を有するものであればよく、モリブデン、タンタル、ステンレス(SUS316)、インコネル、カウール、アスペスト等が挙げられる。

【0033】加熱手段26は所定の熱容量、反応性等を20備えたものであればよく、例えばタンタル線ヒータ、シーズヒータ等が挙げられる。加熱手段に26による加熱温度は、好ましくは100~1400°C程度、温度制御の精度は、蒸発させる材料により異なるが、例えば1000°Cで±1°C、好ましくは±0.5°C程度である。温度検出手段27は、るっぽ23中の材料25の温度を適正に検出しうるものであればよく、例えば、白金-白金ロジウム、タングステン-タングステンレニウム等の熱電対等が挙げられる。

【0034】30【実施例】次に実施例を挙げ、本発明をより具体的に説明する。

【0035】<実施例1>図1に示すように、真空槽内に大きさ250×250mmの基板2を用意し、この基板2の端部(a)から137.5mmの距離(b)まで蒸発源を移動させ、それぞれの位置(図中入射位置として基板の中央から端部までの距離との比として表示する。)で蒸着を行い、得られた各蒸着膜について膜厚分布を測定した。このときのn値は3, 4, 5または6のいずれかの値とし、蒸着材料にはA1q3を用いた。また、基板2から蒸発源4開口部24までの距離は50cmとした。得られた結果を図3に示す。

【0036】図3から明らかのように、本発明の装置によれば、3~6のいずれのn値においても膜厚分布が±10%以内となっていることがわかる。

【0037】<実施例2>実施例1において、n値を3~6のいずれかの値とし、蒸発源から基板2までの距離を200~800mmに移動させ、それぞれの位置で蒸着を行い、得られた各蒸着膜について膜厚分布を測定した。このときの蒸着材料にはA1q3を用いた。また、基板2の中央から蒸発源4までの距離は30cmとした。

得られた結果を図4に示す。

【0038】図4から明らかなように、本発明の装置によれば、3~6のいずれのn値においても膜厚分布が±10%以内となっていることがわかる。

【0039】<実施例3>実施例1で用いた蒸着材料に代えて、TPD (N, N'-ジフェニル-N, N'-m-トリル-4, 4'-ジアミノ-1, 1'-ビフェニル) を用いた他は実施例1と同様にして製膜したところ、ほぼ同様な結果が得られた。

【0040】<実施例4>実施例1で用いた蒸着材料に代えて、Mgを用いた他は実施例1と同様にして製膜したところ、ほぼ同様な結果が得られた。

【0041】<実施例5>実施例3で用いた蒸着材料に加えて、ルブレンを用いた。これら各蒸着材料が備えられた各蒸発源4をそれぞれ用意し、これらを実施例1と同一条件となるよう同心円上に配置し、各蒸発源4の蒸着速度(加熱温度)をコントロールしてTPD:ルブレンが、100:10となるように共蒸着を行った他は実施例3と同様にして製膜したところ、ほぼ同様な結果が得られた。

【0042】

【発明の効果】以上のように本発明によれば、比較的大きな面積の基板に対応し、膜厚分布の変動が少なく、有

機EL素子を効率よく量産することのできる有機EL素子の製造装置および製造方法を実現できる。

【図面の簡単な説明】

【図1】本発明の装置の概略構成を示す半裁断面図である。

【図2】本発明の装置に好ましく使用されるクヌードセンセルの要部断面図である。

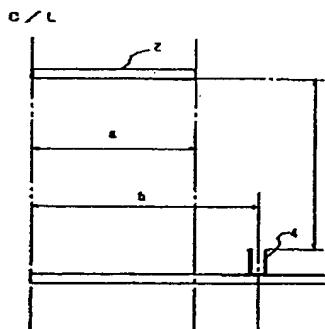
【図3】各n値における、基板中央に対する蒸発源の位置を変化させたときの膜厚分布を示したグラフである。

【図4】各n値における、蒸発源から基板2までの距離を200~800mmとしたときの膜厚分布を示したグラフである。

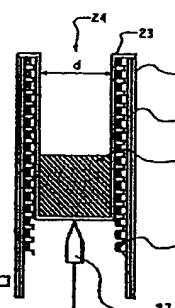
【符号の説明】

2	基板
3	蒸発源載置台
4	蒸発源
21	外部ケース
22	断熱材
23	るつぼ
24	開口部
25	材料
26	加熱手段
27	温度測定手段

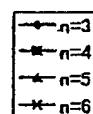
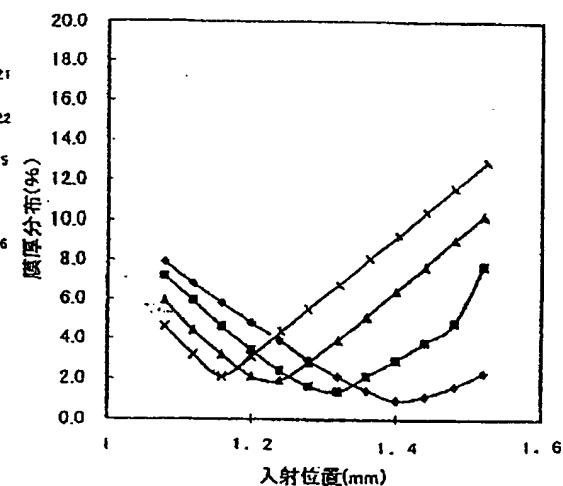
【図1】



【図2】



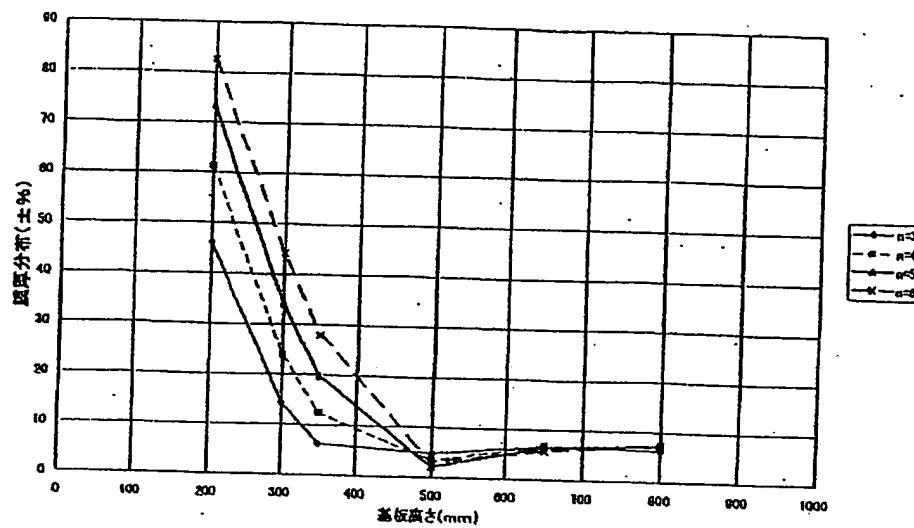
【図3】



(7)

特開平10-335062

【図4】



PTO 00-1648

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DEVICE AND METHOD FOR MANUFACTURING ORGANIC EL ELEMENT

Michio Arai et al.

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DEVICE AND METHOD FOR MANUFACTURING ORGANIC EL ELEMENT

[Yuki EL soshi no seizo sochi oyobi seizo hoho]

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[There are no amendments to this patent.]

Claims

1. A device for manufacturing an organic EL element characterized by the following facts:

the manufacturing device for the organic EL element has a substrate for forming the organic EL element and it has an evaporation source;

the ratio of m/m_0 , where m_0 represents the vapor density at the center above the opening of said evaporation source at distance L_0 from the opening and m represents the vapor density at any position at distance L from the opening and at a radiating angle θ from the central line of the opening, is approximately proportional to $(L_0/L)^2 \cdot \cos^n \theta$, and n has a value of 3-6;

with respect to the center of the substrate, the location of the evaporation source is at a position 1.0-1.4 times the distance from the center of the substrate to the end portion of the substrate;

the vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times the distance from the center of the substrate to the end portion.

2. The device for manufacturing the organic EL element described in Claim 1, characterized by the fact that the maximum length of said substrate is in the range of 200-600 mm.

3. The device for manufacturing evaporation source described in Claim 1 or 2, characterized by the fact that the distribution of the film thickness of the organic layer formed is within $\pm 10\%$.

4. A method for manufacturing an organic EL element characterized by the following facts:

the substrate for forming the organic EL element is set in a vacuum container;

an evaporation source is set with respect to the center of said substrate at a position 1.0-1.4 times the distance from the center of the substrate to the end portion of the substrate;

the vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times the distance from the center of the substrate to the end portion;

and the value of n of said evaporation source for performing the vapor deposition is 3-6.

Detailed explanation of the invention

[0001]

Technical field of the invention

This invention pertains to a device for manufacturing an organic EL element. More specifically, this invention pertains to a device for manufacturing an organic EL element characterized by the fact that the organic feed substance for the organic EL element is evaporated under heating, and it is deposited on the film forming region on the substrate to form a thin film.

[0002]

Prior art

The vacuum vapor deposition method is a basic technology for forming thin films. This vacuum vapor deposition method requires an appropriate combination of an evaporation source and a substrate for forming the film in a vacuum vessel. In this configuration, a thin film is formed. Various methods have been proposed as means for forming the evaporation source. For example, in the so-called resistance heating vapor deposition method proposed in Appl. Phys. Lett., 68(16), April 15, 1996, a current flows in a metal container (metal board) having a

relatively high electrical resistance, and the heat generated by the current is used to evaporate the feed material. There is also the so-called electron beam/laser beam vapor deposition method in which an electron beam or a laser beam is irradiated directly on a feed material and the energy is used to evaporate the feed material. Among these, the method of film formation using resistance heating (resistance heating vapor deposition method) has a simple configuration for the film forming device, and it can form a thin film with high quality at low cost. Consequently, it has become very popular.

[0003]

In the resistance heating vapor deposition method, a metal material with a high melting point, such as tungsten, tantalum, molybdenum, or the like, is processed to a thin sheet, which is used to form a feed material container (metal board) made of the metal with high resistance. Then, a DC current flows by [applying power] across its two ends. The heat generated by the DC current evaporates the feed material to provide the vapor needed for vapor deposition. Figure 3 [sic] is a schematic diagram illustrating the configuration of a resistance heating vapor deposition device. In this device, in vacuum container (1), substrate S and metal board (4b) facing said substrate S are set. A small hole is formed on the upper portion of feed material container (4a) formed of said metal board (4b). Under heating, feed material vapor V is emitted from the hole. A portion of the emitted vapor is deposited on substrate S to form a thin film. Any substance having a relatively high vapor pressure may be used as the feed material of vapor deposition. However, any substance that might chemically react with the container of the feed material should be avoided.

[0004]

Using the resistance heating device, there is little damage to the organic layer, and this is an advantage for the device for vapor deposition of the structural thin film of the organic EL element, such as a cathode electrode, etc. However, in order to ensure that a uniform film thickness is realized, the size of the substrate that can be treated using the vacuum vapor deposition device is limited to about 100 x 100 mm. This is rather small. Consequently, in the case of mass production of displays, etc. as applications of organic EL elements, the quantity of displays that can be manufactured in a batch is small, and the productivity is poor. Also, the size of the image [plate] that can be manufactured is limited, so it is hard to meet the demand for larger display pictures.

[0005]

On the other hand, when a film is manufactured with no requirement for variation in film thickness, it is possible to form the film on a larger substrate. However, in this case, the characteristics are unstable, the defective product rate is high, the dispersion in luminance and unevenness in display become serious within each display, and it is hard to obtain products with sufficient quality for practical use.

[0006]

Problems to be solved by the invention

The object of this invention is to solve the aforementioned problems of conventional technology by providing a device and a method for manufacturing an organic EL element, characterized by the fact that substrates having a relatively large area can be handled, dispersion in film thickness distribution is small, and mass production of organic EL elements can be carried out at high efficiency.

[0007]

Means to solve the problems

The aforementioned objective can be realized by means of the following features (1)-(4) of the constitution.

(1) A device for manufacturing an organic EL element is characterized by the following facts: the manufacturing device for an organic EL element has a substrate for forming the organic EL element and an evaporation source; the ratio of m/m_0 , where m_0 represents the vapor density at the center above the opening of said evaporation source at distance L_0 from the opening, and m represents the vapor density at any position at distance L from the opening and at a radiating angle θ from the central line of the opening, is approximately proportional to $(L_0/L)^2 \cdot \cos^n \theta$, and n has a value of 3-6; with respect to the center of the substrate, the location of the evaporation source is at a position 1.0-1.4 times the distance from the center of the substrate to the end portion of the substrate; the vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times the distance from the center of the substrate to the end portion.

(2) The device for manufacturing the organic EL element described in said (1) is characterized by the fact that the maximum length of said substrate is in the range of 200-600 mm.

(3) The device for manufacturing the evaporation source described in said (1) or (2) is characterized by the fact that the distribution of the film thickness of the organic layer formed is within $\pm 10\%$.

(4) A method for manufacturing an organic EL element is characterized by the following facts: the substrate for forming the organic EL element is set in a vacuum vessel; an evaporation source is set with respect to the center of said substrate at a position 1.0-1.4 times the distance from the center of the substrate to the end portion of the substrate; the vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times the distance from the center of the substrate to the end portion; and the value of n of said evaporation source is 3-6 for performing the vapor deposition.

[0008]

Embodiment of the invention

The manufacturing device of the organic EL element of this invention has a substrate for forming the organic EL element and an evaporation source; the ratio of m/m_0 , where m_0 represents the vapor density at the center above the opening of said evaporation source and at distance L_0 from the opening, and m represents the vapor density at any position at distance L from the opening and at a radiating angle θ from the central line of the opening, is approximately proportional to $(L_0/L)^2 \cdot \cos^6 \theta$, and n has a value of 3-6; the location of the evaporation source with respect to the center of the substrate is at a position 1.0-1.4 times the distance from the center of the substrate to the end portion of the substrate; the vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times the distance from the center of the substrate to the end portion. In this way, with respect to the value of n in a prescribed range, by setting the evaporation source at a prescribed position from the center of the substrate, it is possible to realize a uniform film thickness distribution.

[0009]

There is no special limit on the type of the substrate used. Any substrate that allows lamination of the organic EL element may be used. When it is to be installed on the side where the generated light is output, the substrate should be made of a transparent or semi-transparent material, such as glass, quartz, resin, etc. Also, the substrate may be coated with color filtering film, color converting film containing a fluorescent substance, or a dielectric reflective film so as to control the emitted light. On the other hand, if it is to be installed on the side where the generated light is not output, the substrate may be either transparent or opaque. When an opaque substrate is used, ceramics may be used.

[0010]

There is no special limit on the size of the substrate. In particular, the maximum length, that is, the diagonal dimension, should be in the range of 200-700 mm, or preferably in the range

of 400-700 mm. There is no problem if the maximum length is smaller than 200 mm. However, a substrate with a maximum length of 200 mm or larger is preferred for realizing a uniform film thickness distribution. On the other hand, when the size of the substrate is larger than 700 mm, the film forming device becomes too large, the film forming efficiency becomes lower, and it is hard to control the film thickness.

[0011]

There is no special limit on the type of evaporation source. Any material may be used as long as it does not react easily with the materials of the organic EL element and it can diffuse the vapor at a prescribed value of n . However, the Knudsen cell (referred to as K cell hereinafter) is preferred. The K cell has a prescribed opening on the vapor ejecting port. If the opening has a diameter of d and thickness of t , which are taken as parameters, the distribution of the vapor density formed above the injecting port forms a candle flame shape, which can be represented approximately as $\cos^n\theta$. Here, n is the value when the ratio of the vapor density m_0 at the center to the vapor density m at any position, m_0/m , is approximately represented as $\cos^n\theta$. As the value of d/t decreases, the value of n becomes larger, and the shape of the flame becomes longer. In the extreme case when $t=0$, one has $n=1$, and the distribution of the vapor density becomes a [hemi]sphere standing on the opening portion. This corresponds to the case of evaporation from an open liquid surface, and is called Langmuir evaporation.

[0012]

Said value of n is controlled to be in the range of 3-6 by controlling d/t , etc. In this way, since the value of n is kept in a prescribed range, even when the vapor evaporated from the opening portion of the evaporation source, that is, the orifice, is not constant and the value of n also varies, as long as the value of n is within the aforementioned range, operation can be performed free of any problem. If the value of n is smaller than the aforementioned range, the diffusion direction expands too much, and the film forming efficiency decreases. On the other hand, if the value of n is larger than the aforementioned range, the directionality becomes more significant, and it is hard to handle large substrates.

[0013]

The evaporation source is set with respect to the center of said substrate at a position 1.0-1.4 times, or preferably 1.0-1.3 times, or more preferably 1.1-1.3 times the distance from the center of the substrate to the end portion of the substrate. The vertical distance from the opening of said evaporation source to the substrate is 1.5-3.5 times, or preferably 1.5-3.0 times, or more preferably 1.5-2.5 times the distance from the center of the substrate to the end portion. By

setting [the evaporation source] at a position at the prescribed distance from the center of the substrate, it is possible to control the distribution of the film thickness within a prescribed value, and it is possible to obtain an organic EL element with stable characteristics. As long as the positions are within the aforementioned range, plural evaporation sources may be set on a concentric circle with respect to the center of the substrate. In this case, it is also possible to perform co-deposition.

[0014]

The film thickness distribution of the formed thin film should be within $\pm 10\%$, or preferably within 9%, or more preferably within 8%. If the film thickness distribution is larger than $\pm 10\%$, the characteristics of the obtained organic EL element become unstable.

[0015]

Examples of thin films of the organic EL element formed using the device of this invention include hole injecting/transporting layers, light emitting and electron injecting/transporting layers, electron injecting electrodes, protective layers, etc. Examples [of the substrate] include metals, alloys, organic materials, etc. which have the same composition as that of said thin films or obtain the same composition by means of vapor deposition.

[0016]

It is preferred that the electron injecting electrode be made of a substance having a low work function, such as K, Li, Na, Mg, La, Ce, Ca, Sr, Ba, Al, Ag, In, Sn, Zn, Zr, and other metal elements, as well as their binary or tertiary alloys prepared to further improve stability. Examples of alloys that may be used include Ag/Mg (with Ag in the range of 1-20 at%), Al/Li (with Li in the range of 0.5-10 at%), In/Mg (with Mg in the range of 50-80 at%), Al/Ca (with Ca in the range of 5-20 at%), etc.

[0017]

Examples of protective layers include metals, SiO_x and other inorganic materials, as well as Teflon and other organic materials.

[0018]

A fluorescent substance is used as the compound having a light emitting function in the light emitting layer. A fluorescent substance of this type is at least one type selected from the compounds disclosed in Japanese Kokai Patent Application No. Sho 63[1988]-264692, such as quinacridone, rubrine, styryl-based pigments, etc. Also, tris(8-quinolinolato)aluminum and other

metal complex pigments having 8-quinolinol or its derivatives as ligands, and other quinoline derivatives, tetraphenylbutadiene, anthracene, perylene, chronene, 12-phthaloperynone derivatives, etc. may also be used. Examples also include the phenylanthracene derivatives described in Japanese Patent Application No. Hei 6[1994]-110569, the tetra-arylethene derivatives described in Japanese Patent Application No. Hei 6[1994]-114456, etc.

[0019]

Also, it is preferred that the compound be used in combination with a host substance which can emit light by itself. That is, it is preferably used as a dopant. In this case, the content of the compound in the light emitting layer should be in the range of 0.01-10 wt%, or preferably in the range of 0.1-5 wt%. By using it in combination with a host substance, it is possible to change the light emitting wavelength characteristics of the host substance, it is possible to emit a light spectrum shifted to a longer wavelength, and it is possible to improve the light emitting efficiency and stability of the element.

[0020]

As the host substance, a quinolinolato complex is preferred. In particular, aluminum complexes with 8-quinolinol or its derivatives as ligands are more preferred. Examples of aluminum complexes of this type are disclosed in Japanese Kokai Patent Application Nos. Sho 63[1988]-264692, Hei 3[1991]-255190, Hei 5[1993]-70733, Hei 5[1993]-258859, Hei 6[1994]-215874, etc.

[0021]

Specific examples include tris(8-quinolinolato) aluminum, bis(8-quinolinolato) magnesium, bis(benzo{f}-8-quinolinolato) zinc, bis(2-methyl-8-quinolinolato) aluminum oxide, tris(8-quinolinolato) indium, tris(5-methyl-8-quinolinolato) aluminum, 8-quinolinolato lithium, tris(5-chloro-8-quinolinolato) gallium, bis(5-chloro-8-quinolinolato) calcium, 5,7-dichloro-8-quinolinolato aluminum, tris(5,7-dibromo-8-quinolinolato) aluminum, poly(zinc (II)-bis(8-hydroxy-5-quinolinol) methane), etc.

[0022]

Aluminum complexes having other ligands in addition to 8-quinolinol or its derivatives may also be used. Examples of such aluminum complexes include bis(2-methyl-8-quinolinolato)(phenolato) aluminum(III), bis(2-methyl-8-quinolinolato)(ortho-cresolato) aluminum(III), bis(2-methyl-8-quinolinolato)(meta-cresolato) aluminum(III),

bis(2-methyl-8-quinolinolato)(para-cresolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(ortho-phenylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(meta-phenylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(para-phenylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,3-dimethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,6-dimethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(3,4-dimethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(3,5-dimethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(3,5-di-tert-butylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,6-diphenylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,4,6-triphenylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,3,6-trimethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2,3,5,6-tetramethylphenolato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(1-naphtholato) aluminum(III),
 bis(2-methyl-8-quinolinolato)(2-phenolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato)(ortho-phenylphenolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato)(para-phenylphenolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato)(meta-phenylphenolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato)(3,5-dimethylphenolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato)(3,5-di-tert-butylphenolato) aluminum(III),
 bis(2-methyl-4-ethyl-8-quinolinolato)(para-cresolato) aluminum(III),
 bis(2-methyl-4-methoxy-8-quinolinolato)(para-phenylphenolato) aluminum(III),
 bis(2-methyl-5-cyano-8-quinolinolato)(ortho-cresolato) aluminum(III),
 bis(2-methyl-6-trifluoromethyl-8-quinolinolato)(2-phenolato) aluminum(III), etc.

[0023]

Examples also include bis(2-methyl-8-quinolinolato)
 aluminum(III)- μ -oxo-bis(2-methyl-8-quinolinolato) aluminum(III),
 bis(2,4-dimethyl-8-quinolinolato) aluminum(III)- μ -oxo-bis(2,4-dimethyl-8-quinolinolato)
 aluminum(III), bis(4-ethyl-2-methyl-8-quinolinolato)
 aluminum(III)- μ -oxo-bis(4-ethyl-2-methyl-8-quinolinolato) aluminum(III),
 bis(2-methyl-4-methoxyquinolinolato)
 aluminum(III)- μ -oxo-bis(2-methyl-4-methoxyquinolinolato) aluminum(III),
 bis(5-cyano-2-methyl-8-quinolinolato)
 aluminum(III)- μ -oxo-bis(5-cyano-2-methyl-8-quinolinolato) aluminum(III),

bis(2-methyl-5-trifluoromethyl-8-quinolinolato)
aluminum(III)- μ -oxo-bis(2-methyl-5-trifluoromethyl-8-quinolinolato) aluminum(III), etc.

[0024]

Other preferable host substances include the phenylanthracene derivatives described in Japanese Patent Application No. Hei 6[1994]-110569 and the tetra-arylethene derivatives described in Japanese Patent Application No. Hei 6[1994]-114456.

[0025]

The light emitting layer may also act as an electron injecting/transporting layer. In such case, it is preferred that tris(8-quinolinolato) aluminum or the like be used. Such fluorescent substances may be vapor-deposited.

[0026]

Compounds with the electron injecting/transporting property include quinoline derivatives, as well as metal complexes having 8-quinolinol or its derivatives as ligands, in particular, tris(8-quinolinolato) aluminum (Al q3). Also, it is preferred to make use of said phenylanthracene derivatives and tetra-arylethene derivatives.

[0027]

Preferable compounds for the hole injecting/transporting layer include amine derivatives having a high fluorescence level, such as the triphenyldiamine derivatives as said hole transporting materials, as well as styrylamine derivatives, amine derivatives having aromatic condensed rings, etc.

[0028]

The pressure during vapor deposition is preferably in the range of 1×10^{-8} to 1×10^{-5} torr. The heating temperature of the evaporation source is preferably in the range of 100-1400°C for metal materials, and in the range of 100-500°C for organic materials.

[0029]

In the following, explanations will be provided on the specific configuration of the manufacturing device in this invention with reference to figures.

[0030]

Figure 1 is a half-cut cross-sectional view illustrating the basic configuration of the device of this invention. As shown in the figure, the manufacturing device of an organic EL element in this invention comprises substrate (2), evaporation source carrying table (3), and evaporation source (4). The figure illustrates the right half cut from the central C/L. Consequently, evaporation source (4) is set at a position where vertical distance c from opening portion (24) of evaporation source (4) to substrate (2), which evaporation source is in the range of distance a from the center of the substrate between substrate radius a and distance b that is 1.4 times said radius a, is in the range of 1.5-3.5 times the distance from center C/L of substrate (2) to the end portion. Also, the position of evaporation source (4) refers to the center of evaporation source (4).

[0031]

Figure 2 is a cross-sectional view of the main portion illustrating the specific configuration of evaporation source (4) preferably used in this invention. In this figure, evaporation source (4) has external case (21), heat insulating material (22), crucible (23), opening (24), deposition material (25), heating means (26), and temperature detecting means (27).

[0032]

It is preferred that crucible (23) not react easily with vapor deposited material (25) and be able to withstand a prescribed temperature. Examples of materials of the crucible include pyrolytic boron nitride (PBN), alumina and other ceramics, quartz, etc. In particular, PBN is preferred. There is no special limit on external case (21) as long as it has a prescribed strength and corrosion resistance. The material may be selected from the same types as for heat insulating material (22) listed below, and it is possible to use the same material for both purposes. For example, molybdenum or the like can be used. Heat insulating material (22) should have high heat reflectivity, heat resistance, corrosion resistance, etc. Examples include molybdenum, tantalum, stainless steel (SUS316), Inconel, cowwool [transliteration], asbestos, etc.

[0033]

Heating means (26) should have the prescribed thermal capacity, reactivity, etc. Examples include a tantalum wire heater, sheath heater, etc. The heating temperature by said heating means (26) is preferably in the range of 100-1400°C. The precision of temperature control depends on the material for evaporation, and it may be $1000^{\circ}\text{C} \pm 1^{\circ}\text{C}$ or preferably $\pm 0.5^{\circ}\text{C}$. Temperature detecting means (27) should be able to detect the temperature of material

(25) in crucible (23) appropriately. Examples include a platinum-platinum/rhodium thermocouple, tungsten-tungsten/rhenium thermocouple, and other thermocouples.

[0034]

Application examples

In the following, this invention will be explained in more detail with reference to application examples.

[0035]

Application Example 1

As shown in Figure 1, substrate (2) measuring 250 x 250 mm was set in a vacuum container. An evaporation source was moved from end portion (a) of substrate (2) to position (b) at a distance of 137.5 mm, and vapor deposition was performed at each position (in the figure, the incident position is represented as the ratio to the distance from the center of the substrate to the end portion). For each vapor deposited film, the film thickness distribution was measured. In this case, the value of n was taken as 3, 4, 5 and 6, respectively, and Al q3 was used as the evaporation material. Also, the distance from substrate (2) to opening (24) of evaporation source (4) was selected as 50 cm. The obtained results are shown in Figure 3.

[0036]

As can be seen from Figure 3, for the device of this invention, the distribution of the film thickness is within $\pm 10\%$ for each value of n in the range of 3-6.

[0037]

Application Example 2

In [the same configuration as in] Application Example 1, the value of n was selected at each value in the range of 3-6, and the distance from the evaporation source to substrate (2) was changed in the range of 200-800 mm. At each position, vapor deposition was carried out, and, for each vapor deposited film obtained, the distribution of the film thickness was measured. In this case, Al q3 was used as the evaporation material. Also, the distance from the center of substrate (2) to evaporation source (4) was selected as 30 cm. The obtained results are shown in Figure 4.

[0038]

As can be seen from Figure 4, for the device of this invention, the distribution of the film thickness is within $\pm 10\%$ for each value of n in the range of 3-6.

[0039]

Application Example 3

Film formation was performed in the same way as in Application Example 1, except that instead of the evaporation material used in Application Example 1, TPD (N,N'-diphenyl-N,N'-m-tolyl-4,4'-diamino-1,1'-biphenyl) was used. The results were found to be nearly the same [as in Application Example 1].

[0040]

Application Example 4

Film formation was performed in the same way as in Application Example 1, except that instead of the evaporation source material used in Application Example 1, Mg was used. The results were found to be nearly the same [as in Application Example 1].

[0041]

Application Example 5

Rubrine was used along with the evaporation material used in Application Example 3, and the evaporation sources (4) having different evaporation materials were set in a concentric circle under the same conditions as in Application Example 1. In this case, the vapor deposition rates (heating temperatures) of the various evaporation sources (4) were controlled to form co-deposition of TPD:rubrine of 100:10. Otherwise, the operation was performed in the same way as in Application Example 3. The obtained results were nearly the same.

[0042]

Effect of the invention

As explained in the above, according to this invention, it is possible to realize a device and method for manufacturing an organic EL element, characterized by the fact that it can handle a substrate having a relatively large area, it produces little variation in the film thickness distribution, and it can perform high-efficiency mass production of the organic EL element.

Brief description of the figures

Figure 1 is a half-cut cross-sectional view illustrating the schematic configuration of the device in this invention.

Figure 2 is a cross-sectional view of the main portion of the K cell used preferably in the device of this invention.

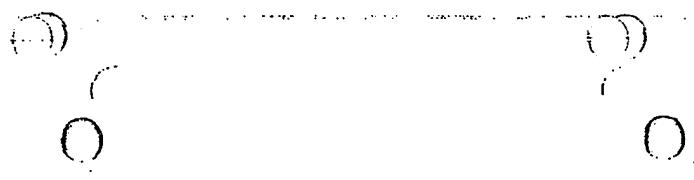
Figure 3 is a graph illustrating film thickness distribution when the [lateral] position of the evaporation source is changed with various values of n.

Figure 4 is a graph illustrating film thickness distribution when the [vertical] distance from the evaporation source and substrate (2) is in the range of 200-800 mm with various values of n .

Explanation of symbols

- 2 Substrate
- 3 Evaporation source carrying table
- 4 Evaporation source
- 21 External case
- 22 Heat insulating material
- 23 Crucible
- 24 Opening
- 25 Deposition material
- 26 Heating means
- 27 Temperature measurement means

Figure 1



15

Figure 2

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Figure 3

Key: 1 Film thickness distribution
2 Incident position

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Figure 4

Key: 1 Distribution of film thickness
2 Height of substrate

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